

AMENDMENTS TO THE CLAIMS

The following is a complete, marked up listing of revised claims with a status identifier in parentheses, underlined text indicating insertions, and strikethrough and/or double-bracketed text indicating deletions.

Listing of Claims

1. (Currently Amended) An interventional procedure simulation system, having a control unit and an interface unit, said control unit communicating with said interface unit to simulate handling of a number of real nested instruments simultaneously interfaced by said interface unit and, said instruments being arranged to move and rotate independently of each other and said movements and rotations being propagated to the other instruments, said control unit including an instruction set comprising:
 - a first instruction set for handling and processing an input from a user,
 - based on said input, generating a second instruction set for controlling said interface,
 - a first data set comprising characteristics for said instruments,
 - a second data set comprising data on a body part to be simulated,
 - a third instruction set for generating control signals relating to an interaction between said simulated instruments and a surrounding geometry relating to a part of said simulated body part,
 - a fourth instruction set for controlling movements of a number of serially arranged and interconnected carriages corresponding to movements of said instruments in said interface unit, each carriage comprising:
 - members to receive and lock at least one of the instruments, and members for receiving a movement from ~~[[the]]~~an instrument dummy and generating a force fed back to the instrument dummy with respect to a simulation characteristic,

a detecting arrangement for detecting the type of the instruments inserted through ~~[[a]]~~an interconnecting member,

means to provide the movement of each carriage and regulate the movement by means of a speed regulator and a distance regulator,

a crank block, arranged on a torque wheel, and

an outlet, which is provided with a detecting member, configured to detect presence of at least one instrument in the carriage, said detecting member being arranged to detect the thickness of each instrument, ~~[[and]]~~

a fifth instruction set for calculating an effect of a first instrument inserted into a second instrument in a nested manner, each instrument having properties, being at least one of a natural shape, stiffness, length, diameter and radioopacity, said instruction set being configured to calculate movements of said first instrument propagated to the second instrument and

a sixth instruction set for modeling a color agent which calculates behavior of said color agent and keeps track of a position currently having enough concentration of contrast to be visualized.

2. (Previously Presented) The system of claim 1, wherein said interventional procedure is at least one of a diagnostic, a cardiovascular or endovascular simulation system.

3. (Previously Presented) The system of claim 1, wherein a user's movements of said instruments, a surrounding simulated anatomy and other present instruments, affect a shape of an instrument simulated and displayed.

4. (Previously Presented) The system of claim 3, wherein for each instrument collisions with simulated surrounding calculations are executed by said control unit, which affects the shape and position of said instrument in said simulated body part.

5. (Previously Presented) The system of claim 1, wherein an instrument is a distal part of a tool or an end of a tool.

6. (Previously Presented) The system of claim 1, wherein different instrument types can be used comprising at least one of balloons, stems, electrodes, wires, catheters, and distal protection.

7. (Previously Presented) The system of claim 6, wherein each instrument type has different properties associated to it and provided as an instruction set, which describes substantially all properties of said instrument.

8. (Previously Presented) The system of claim 6, wherein the properties of said instruments further describe interaction with at least one of surrounding geometry, visual properties, stiffness, and shape.

9. (Previously Presented) The system of claim 8, wherein simulated properties of said instrument are altered in real-time.

10. (Previously Presented) The system of claim 1, wherein the system comprises a model used for rendering objects depending on properties to be displayed and a collision model for computing collisions between the simulated

instrument and body part.

11. (Previously Presented) The system of claim 1, wherein a model of said body or part of said body part is a three-dimensional data obtained through a body scanning.

12. (Cancelled)

13. (Currently Amended) A method for simulating an interventional procedure, comprising the steps of:

providing a control unit and an interface unit, said control unit communicating with said interface unit to simulate handling of a number of nested real instruments simultaneously interfaced by said interface unit and that each nested tool is configured to be moved and rotated independently of the other and said movements and rotations are propagated to other instruments, and said interface unit including an instruction set for controlling movements of a number of serially arranged and interconnected carriages, corresponding to movements of said instruments in said interface device each carriage comprising:

members to receive and lock at least one of the instruments, and
members for receiving a movement from the instrument dummy and
generating a force fed back to the instrument dummy with respect to a
simulation characteristic,

a detecting arrangement for detecting the type of the instruments
inserted through an interconnecting member,

means to provide the movement of each carriage and regulate the

movement by means of a speed regulator and a distance regulator,
a crank block, arranged on a torque wheel, and
an outlet, which is provided with a detecting member, configured to
detect presence of at least one instrument in the carriage, said detecting
member being arranged to detect the thickness of each instrument,
providing a first instruction set for handling and processing input from a
user,
generating a second instruction set based on said input, for controlling said
interface,
retrieving information on said instrument comprising a first data set
comprising characteristics for said instruments,
providing a second data set comprising data on a body part to be simulated,
generating control signals relating to interaction between said instrument and
a surrounding geometry by a third instruction set,
controlling movements of a number of serially arranged and interconnected
carriages corresponding to movements of said instruments in said interface unit,
calculating an effect of a first instrument inserted into a second instrument in a
nested manner, each instrument having properties, being at least one of a natural
shape, stiffness, length, diameters and radioopacity, [[and]]
calculating movements of said first instrument propagated to the second
instrument, and
modeling a color agent by calculating behavior of said color agent and keeps
track of a position currently having enough concentration of contrast to be visualized.

14. (Previously Presented) The method of claim 13, changing instrument

simulated and displayed based on a user's movements of said instruments, a surrounding simulated anatomy and other present instruments, effect a shape of an instrument simulated and displayed.

15. (Previously Presented) The method of claim 13, wherein an instrument is a distal part of a tool or an end of a tool.

16. (Previously Presented) The method of claim 13, wherein different instrument types can be used comprising at least one of balloons, stents, electrodes, wires, catheters and distal protection.

17. (Previously Presented) The method of claim 16, wherein each instrument type has different properties associated to it and provided as an instruction set, which describes substantially all properties of said instrument.

18. (Previously Presented) The method of claim 16, wherein the properties of said instruments further describe interaction with at least one of surrounding geometry, visual properties, stiffness and shape.

19. (Previously Presented) The method of claim 16, wherein simulated properties of said instrument are altered in real-time.

20. (Currently Amended) A system for an interventional procedure simulation, said system having a control unit and an interface unit, the system comprising:

~~means for~~ a communication interface configured to communicate between said

control unit and said interface unit,

~~means for~~ a simulation arrangement in said interface unit configured to
simultaneously ~~simulating~~ simulate handling of a number of nested instruments
interfaced by said interface unit, each of said instruments being independently
movable and rotatable,

~~[[an]]~~ a user input interface member configured to receive input from a user
including an instruction set,

~~means for~~ a computer configured to handle ~~handling~~ and ~~process~~ processing said
input,

~~means for controlling said~~ an interface controller arrangement,

a first database configured to store characteristics for said instruments,

a second database configured to store characteristics about a body part to be
simulated,

~~means for~~ for a signal generating arrangement configured to ~~generating~~ generate
control signals relating to an interaction between said simulated instruments and a
surrounding geometry relating to a part of said simulated body part,

~~means for controlling~~ a controller configured to control movements of a number of
serially arranged and interconnected carriages corresponding to movements of
said instruments in said interface device, each carriage comprising:

members to receive and lock at least one of the instruments, and
members for receiving a movement from ~~[[the]]~~ an instrument dummy
and generating a force fed back to the instrument dummy with respect
to a simulation characteristic,

a detecting arrangement for detecting the type of the instruments
inserted through ~~[[a]]~~ an interconnecting member,

means to provide the movement of each carriage and regulate the movement by means of a speed regulator and a distance regulator, a crank block, arranged on a torque wheel, an outlet, which is provided with a detecting member, configured to detect a presence of at least one instrument in the carriage, said detecting member being arranged to detect ~~[[the]]~~a thickness of each instrument, and

~~means for simulating~~a computer configured to simulate an effect of a first instrument inserted into a second instrument in a nested manner, each instrument having properties, being at least one of a natural shape, stiffness, length, diameter, and radioopacity, said instruction set being configured to calculate movements of said first instrument propagated to the other second instrument and modeling a color agent and calculating a behavior of said color agent and keep track of a position currently having enough concentration to be visualized.

21. (Previously Presented) The system of claim 20 wherein said characteristics about a body part to be simulated are obtained through a scanning process.

22. (Currently Amended) A computer program for interventional procedure simulation in a system having a control unit and an interface unit, said program comprising:

a communication instruction set for communication between said control unit and said interface unit,

a first instruction set for simulating handling of a number of simulated nested instruments, independently movable and rotatable, simultaneously interfaced by said

interface unit, said control unit including an instruction set, comprising:

- a second instruction set for handling and processing input from a user,
- a third instruction set for controlling said interface,
- a first data set comprising characteristics for said instruments,
- a second data set comprising data on a body part to be simulated,
- a fourth instruction set for generating control signals relating to an interaction between said simulated nested instruments and a surrounding geometry relating to a part of said simulated body part,
- a fifth instruction set for controlling movements of a number of serially arranged and interconnected carriages corresponding to movements of said instruments in said interface device, each carriage comprising:

- members to receive and lock at least one of the instruments, and
 - members for receiving a movement from the instrument dummy and generating a force fed back to the instrument dummy with respect to a simulation characteristic,

- a detecting arrangement for detecting the type of the instruments inserted through ~~[[a]]~~an interconnecting member,

- means to provide the movement of each carriage and regulate the movement by means of a speed regulator and a distance regulator,

- a crank block, arranged on a torque wheel, and

- an outlet, which is provided with a detecting member, configured to detect presence of at least one instrument in the carriage, said detecting member being arranged to detect the thickness of each instrument,

- a sixth instruction set for calculating an effect of a first instrument

inserted into a second instrument in a nested manner, each instrument having properties, being at least one of a natural shape, stiffness, length, diameter and radioopacity, said sixth instruction set being configured to calculate movements of said first instruction instrument propagated to the second instrument, [[and]]

a seventh instruction set for outputting simulation on a visualization member, and

an eighth instruction set for modeling a color agent which calculates a behavior of said color agent and keeps track of a position currently having enough concentration of contrast to be visualized.

23. (Previously Presented) A program storage device readable by a machine and encoding a program of instructions for executing the computer program for interventional procedure simulation according to claim 22.

24. (Currently Amended) A computer readable medium having computer readable program code embodied therein to enable an interventional procedure simulation in a system comprising a control unit and an interface unit having a plurality of carriages, said program comprising:

a communication instruction set for communication between said control unit and said interface unit,

a first instruction set for simulating handling of a number of simulated nested instruments, independently movable and rotatable, simultaneously interfaced by said interface unit, said control unit further ~~comprising~~ including an instruction set[[.]] comprising:

a second instruction set for handling and processing input from a user,

a third instruction set for controlling said interface,
a first data set comprising characteristics for said instruments,
a second data set comprising data on a body part to be simulated,
a fourth instruction set for generating control signals relating to an interaction between said simulated nested instruments and a surrounding geometry relating to a part of said simulated body part, each carriage comprising:

members to receive and lock at least one of the instruments, and
members for receiving a movement from the instrument dummy and
generating a force fed back to the instrument dummy with respect to a
simulation characteristic,

a detecting arrangement for detecting the type of the instruments
inserted through [[a]]an interconnecting member,

means to provide the movement of each carriage and regulate the
movement by means of a speed regulator and a distance regulator,

a crank block, arranged on a torque wheel, and

an outlet, which is provided with a detecting member, configured to
detect presence of at least one instrument in the carriage, said detecting
member being arranged to detect the thickness of each instrument;

a fifth instruction set for calculating an effect of a first instrument inserted into
a second instrument in a nested manner, each instrument having properties, being at
least one of a natural shape, stiffness, length, diameter and radioopacity, said fifth
instruction set being configured to calculate movements of said first instrument
propagated to the second instrument, [[and]]

a sixth instruction set for outputting simulation on a visualization member, and
a seventh instruction set for modeling a color agent which calculates a behavior

of said color agent and keeps track of a position currently having enough concentration of contrast to be visualized.

25. (Cancelled)

26. (Currently Amended) A system for an interventional procedure simulation, said system including a control unit and an interface unit, the system comprising:

~~means for a~~ communication arrangement configured to control communication between said control unit and said interface unit for receiving at least two nested real instruments including a first instrument inserted into a second instrument, used in said interventional procedure,

~~means for receiving a~~ computer configured to receive three-dimensional information on a body part to be simulated, and

~~means for generating an~~ arrangement configured to generate control signals relating to an interaction between said first and second instruments and a surrounding geometry relating to a part of said simulated body part, said control signals being configured to control movements of a number of serially arranged and interconnected carriages corresponding to movements of said instruments in said interface device with respect to movements of said first instrument propagated to the second instrument, each carriage comprising:

members to receive and lock at least one of the instruments, and
members for receiving a movement from ~~[[the]]~~an instrument dummy
and generating a force fed back to the instrument dummy with respect
to a simulation characteristic,

a detecting arrangement for detecting the type of the instruments

inserted through ~~[[a]]~~an interconnecting member,

means to provide the movement of each carriage and regulate the movement by means of a speed regulator and a distance regulator,

a crank block, arranged on a torque wheel, and

an outlet, which is provided with a detecting member, configured to detect the presence of at least one instrument in the carriage, said detecting member being arranged to detect the thickness of each instrument, wherein said control unit controls modeling a color agent by calculating behavior of said color agent and keeps track of a position currently having enough concentration of contrast to be visualized.

27. (Previously Presented) The system of claim 26, wherein said three-dimensional information is obtained through a scanning process.

28. (Cancelled)

29. (Currently Amended) A method of testing new tools for an interventional procedure training procedures, using a system including a control unit and an interface unit, the method comprising:

~~using prototyping~~ a real nested interventional procedure tool, including a first tool inserted into a second tool to be simulated in said interface device, said interface unit including a plurality of carriages, each carriage comprising:

members to receive and lock at least one of the instruments, and members for receiving a movement from the instrument dummy and generating a force fed back to the instrument dummy with respect to a simulation characteristic,

a detecting arrangement for detecting the type of the instruments
inserted through a interconnecting member,

means to provide the movement of each carriage and regulate the
movement by means of a speed regulator and a distance regulator,

a crank block, arranged on a torque wheel, and

an outlet, which is provided with a detecting member, configured to
detect presence of at least one instrument in the carriage, said detecting
member being arranged to detect the thickness of each instrument,

simulating an interaction between said nested first and second tools,
independently movable and rotatable, and a surrounding geometry relating to a
part of said simulated body part,

measuring usability of new features related to said prototyped tool, and

comparing results to predefined values and providing objective

measurements on interactions between a user and the prototyped tool~~using said
simulation for training a user.~~

30. (Cancelled)

31. (New) The system of claim 1, comprising a mapping table executed in a pre-processor.

<End of Claims Listing>